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Acronyms and/or abbreviation

ANC	Antenatal Care
CI	Confidence Interval
CM	Centimeter
CSA	Central Statistics Agency
EDHS	Ethiopian Demographic Health Survey
G/dl	Gram per deciliter
IQ	Intelligent Quotient
ML	Milliliter
MOH	Ministry Of Health
MUAC	Mid-Upper Arm Circumference
NGOs	Non-Governmental Organizations
OR	Odds Ratio
SPSS	Statistical Package for Social Sciences
TSH	Thyroid Stimulating Hormone
µ/g	Microgram
UIC	Urinary Iodine Concentration
WHO	World Health Organization

Abstract

Introduction: All populations are at risk for iodine deficiency, but pregnant women are the most vulnerable groups particularly for those in resource limiting setting like Ethiopia. However, there is paucity of literature in these population groups and study area.

Objective: This study was aimed to assess the prevalence of iodine deficiency and its associated factors among pregnant women attending antenatal care clinic at the University of Gondar Referral Hospital.

Methods: Facility-based cross-sectional study was conducted from March 13 to April 25/2017. A total of 378 pregnant women were included in the study, selected via systematic random sampling technique. Pretested structured questionnaire based interview was used. Urinary Iodine concentration, and hematocrit were determined by spectrophotometer using Sandell-kolhtoff reaction and hematological machine respectively. The binary logistic regression model was fitted to identify factors associated with iodine deficiency. Interpretation was made on the basis of CI and P-value. Odds ratio with 95% confidence interval was calculated to show the strength and direction of association.

Result: A total of 378 pregnant women with response a rate of 94% were participated in the study. The overall subclinical iodine deficiency among pregnant women was found to be 60.5% (95% CI: 55%, 65.5%). With the Midian of 137µg/L. Being governmental employer [AOR=0.42(95% CI: 0.1=20, 0.87)],cabbage consumption twice and more times in a week [AOR= 2.35 (95% CI: 1.44, 3.82)], women who never consume maize in the last one week [AOR= 0.29 (95% CI: 0.18, 0.48)], economic status, being at the second poorer [AOR= 2.7(95% CI: 1.24,5.89)], gestational age, being at second trimester [AOR= 2.43(95% CI: 1.37, 4.32)] were factors associated with iodine deficiency.

Conclusion and recommendation: In this study, subclinical iodine deficiency among pregnant women was found to be mildly iodine deficient. Husband's employment, cabbage, Maize consumption, wealth status, and gestational age were factors associated

with iodine deficiency. Therefore, appropriate nutrition education and means of economical enhancement should be done.

Keywords: Pregnant women, prevalence, iodine deficiency, Northwest Ethiopia.

1. Introduction

1.1. Statement of the problem

Iodine is an essential mineral which is vital for the synthesis of Thyroid Hormone (T3&T4). These hormones are crucial for healthy growth and development of vital organs mainly the brain (1, 2). In consonance with World Health Organization (WHO) iodine deficiency during pregnancy is defined as urinary iodine concentration <150µg/l (3). WHO recommends for pregnant women to take 250 µg/day of iodine to prevent this deficiency (4). In Ethiopia in 2011 to reduce the burden of iodine deficiency a regulation was declared on universal iodized salt utilization by the council of ministers(5). However, several studies exhibited that the problem is still highly prevalent especially in pregnant and children segment of population (6).

Iodine deficiency during pregnancy causes reduction of 12-13.5 points of the newborn's Intelligent Quotient (IQ) after birth (7). This will have later effect on economic productivity and school performance. The WHO estimates around 2.2 billion people are vulnerable to iodine deficiency in 130 countries including Ethiopia (8). In consonance with the United States (US) health care reform shows that 38 million newborns from developing countries are at risk of long-term sequels of brain damage secondary to iodine deficiency(ID)during pregnancy(9). In the words of the WHO and the United Nations International Children's Emergency Fund (UNICEF) more than 78% of Ethiopian population are vulnerable for ID with 26% of goiter rate. Also around 50,000 prenatal deaths are due to ID during pregnancy(10).

Children born from iodine deficient pregnant women had poor educational outcomes related with a decrement in child cognitive capacity than their counterparts(11-16).Moreover, the risk of having poor academic performance is 60% among newborn babies with ID (17).The ill effect of Iodine deficiency is not only limited to neurological abnormality, it also causes low birth weight and small height (17, 18). Plenty of studies in animal models showed that ID leads to a decrement of growth and development of vital organs such as lung and brain including its supportive structures due to low synthesis of thyroxine (T4) (19-21).

National Population survey on ID was conducted in whole part of Ethiopia among reproductive-age groups; the total goiter rate was 35.8%(6 million) which is a severe public health problem (22). Besides, poor pregnancy outcome was noted among women having history of goiter than those who never had. Another study shown in Wombera district, West Gojam Ethiopia yield that nearly 30.1% of pregnant women were iodine deficient and 64% of the women gave birth to cretin children(23). Similarly, the problem was observed in Sidama, Ethiopia nearly half of pregnant women had goiter(24) which is again sever public health problem.

Studies showed that the problem of iodine deficiency in Ethiopia is multifaceted. Firstly, the dietary habit of population where cassava, cabbage, sorghum and millet are staple foods are ID and exposed to its consequences. In addition, poor storage of salt, utilization of non-packed salt, and lack of knowledge about iodized salt are some of the factors which contributes to ID(25, 26). People living in highland areas of the country are iodine deficient due to erosion of iodine with soil which in turn makes cereals and vegetables grow without adequate iodine. The magnitude of iodine deficiency during pregnancy is getting worse as gestational age is advanced(27). In this area inhabitants rarely produce seaweeds and in the counter, vegetable and cereals are staple foods which is believed to cause ID. In the country iodized salt utilization is very low with 23.3% again in the study area iodized salt coverage was low 15.2 % which is far lower than WHO recommendation 90%. Gondar is geographically found in high altitude/mountainous area. Though, ID is one of the grave concerns in Ethiopia little is known about the burden of the problem especially among vulnerable population, notably pregnant women in this district.

Therefore, the purpose this study was twofold, firstly to determine the prevalence of iodine deficiency among pregnant women and secondly, it was aimed to figure out associated factors of iodine deficiency.

1.2. Literature review

1.2.1. **Prevalence of iodine deficiency during pregnancy**

Since iodine has a power of creating vibrant generations preventing iodine deficiency and its associated factors during pregnancy through scientific evidence based investigation is vital work. Therefore, the aim of this study was to assess the prevalence and associated factors of iodine deficiency during pregnancy.

According to the WHO report iodine deficiency in all age group of population was a major public health problem worldwide for instance, America (11%), Europe (50.2%), and Africa (41.5%) (28).

Studies in European countries among pregnant women population group to determine ID by using Urinary Iodine Concentration(UIC) illustrated that, the prevalence of ID was in United States (44%)(29), Canada (25.4%)(30), Southwest England 27%(31) and Czech republic 78.2%(32).While it was found to be 57% among 191 pregnant women in Brazil(33). Likewise, the problem is not only common in developing countries rather it is a problem of developed world for instance, several cross-sectional studies was conducted in Europe among pregnant women through urine iodine test showed that the prevalence of iodine deficiency was in Turkey(28.1%)(34), Viet Nam (83%)(35), Ukraine (95.9%)(36), and France (77%)(37). Similarly, study was done in Hungary among 313 pregnant women by using biochemical markers of UIC the prevalence of iodine deficiency was 57.1 % of which 15.6% women were in severe form, and 19.2 %, and 5.4% of individuals were presented with enlarged and nodular goiter respectively(38).Another studies were conducted among pregnant women through urinary iodine concentration test the prevalence of iodine deficiency from Latvia (81%)(39), Austria (81.2%)(40), Spain (78%) (41), and Nepal (28.9%)(42). While, in Sri Lanka among 477 pregnant iodine deficiency was 65.1%(43)

Studies was conducted among pregnant women through 24 hour urinary iodine concentration method using world health organization as a cutoff point (<150µg) the prevalence of iodine deficiency was in Iran (78.2%)(44), and Bangladesh (80%)(45) Similarly, a cross-sectional study was carried out in Kolkata, India among 273 pregnant

women through urinary iodine concentration the prevalence of iodine deficiency was 37%(46).

A cross-sectional study was conducted in Ghana in 2016 to assess the prevalence of iodine deficiency among pregnant women by using urinary iodine test reported that the prevalence of iodine deficiency was 42.5%(47). Another study in Nigeria was conducted to determine iodine nutrition status among three hundred pregnant women through urinary iodine concentration test using cut point below 100µg/l was considered as deficient and the finding demonstrated that about 100% of pregnant women were iodine deficient(48).

A case-control study was conducted among 240 pregnant women in Niger as cases and 60 non-pregnant women as controls using casual urine Iodine concentration, 61.67 % pregnant women was iodine deficient.(49)

Regardless of governmental effort to eliminate ID in the country through proclamation of universal iodized salt utilization the problem of iodine deficiency is still highly prevalent. Studies from different part of the country witnessed that, Jima (88.9%)(50), Haramaya (82.8%)(51), Lai Gayint (61.4%)(52).

1.2.2. Factors associated with iodine deficiency during pregnancy

Factors associated with iodine deficiency during pregnancy are categorized as dietary factor (milk, egg, maize consumption iodized salt intake, fish consumption, and cabbage consumption), sociodemographic factors (age, educational status, occupation, family size, previous pregnancies, and family history of goiter), obstetric and maternal factors (parity and gravidity, history of abortion, gestational age and knowledge about iodine deficiency).

1.2.2.1. Sociodemographic factors

A cross-sectional study in Zhejiang province in china among pregnant women by using urinary iodine concentration through UV mass-spectrometer analyzer machine and using WHO criteria as a cut of point revealed that age, educational status, and occupation were factors for iodine deficiency(53, 54).

A study in Haramaya among 435 pregnant women demonstrated that women who were 35-49 years old the odds of iodine deficiency was reduced by 70%, concerning to educational status women who were unable to read and write the odds of ID was nearly fourfold higher. Furthermore, having five and more family size was threefold higher to the development of ID (51).Similarly, A cross-sectional study was conducted in Ethiopia, Lai Gayint among pregnant women to determine iodine deficiency using subclinical and physical examination methods the most significant factor for iodine deficiency was having family history of goiter(52).

A case-control study was conducted in Niger 240 pregnant women as cases and 60 non-pregnant women as controls using casual urine Iodine Concentration educational level was significantly associated with iodine deficiency(49).

1.2.2.2. Dietary factors

A cross-sectional study was conducted in south-west England among pregnant women milk intake was negatively associated with iodine deficiency (31). While, study in Turkey showed that adding salt during and after cocking boosts iodine concentration in the urine (34).Similar study shown in Zhejiang province in China, revealed that utilization of iodized salt protective for the development of ID (53). Another randomized control trail was conducted in Thailand among 858 study participants; those participants who were consuming egg shown significant increment of median urinary iodine concentration (55).

A case-control study was conducted in Niger among 240 pregnant women as cases and 60 non-pregnant women as controls using casual urine Iodine Concentration iodized salt utilization was negatively associated with iodine deficiency(49). Besides, a cross-sectional studies was conducted in Kenya (56), and Tajikistan(57) salt container without cover, salt storage in moist area, and duration of salt storage were factors associated with increment the odds of ID.

A study was conducted in Ethiopia, Jima among pregnant women types of salt used and frequency of cabbage intake were associated with iodine deficiency(50).Study in Haramaya among 435 pregnant women demonstrated that the odds ID among three and more times in a month cabbage consumers is threefold. Moreover, iodized salt utilization

(negatively associated), consuming milk three and more times decrease the development of ID by 50%(51). Similarly, community based cross-sectional study was done in lay Armachiho 2012 among 698 school age children to determine the burden of ID among the dietary factors sorghum and fish consumption was negatively associated with goiter. While, course/non packed salt and salt storage without cover was positively associated with ID(26).

1.2.2.3. Obstetric and maternal factors

A cross-sectional study was done in Trabzon city, Turkey on pregnant women one of the factor which was significant for iodine deficiency was gestational age the iodine concentration among first trimester was higher than that of second and third trimester of pregnancy(58).

A cross-sectional study was conducted in Ethiopia, Lay Gayint among pregnant women by using urinary iodine concentration revealed that gestational age (third trimester negatively associated) with ID during pregnancy(52). The established fact is that as number of pregnancy increases micronutrient depletion increased. Unlike this fact a study from Haramaya among pregnant women showed that the odds of developing iodine deficiency among multiparous women was decreased by 77%(51). A case-control study was conducted in Niger 240 pregnant women as cases and 60 non-pregnant women as controls using casual urine Iodine Concentration gestational age was significantly associated with iodine deficiency(49).

1.2.2.4. Nutritional status

Studies from China (59), and Switzerland(60) showed that iodine deficiency and thyroid dysfunction was associated with iron deficiency anemia.

Conceptual framework of the study

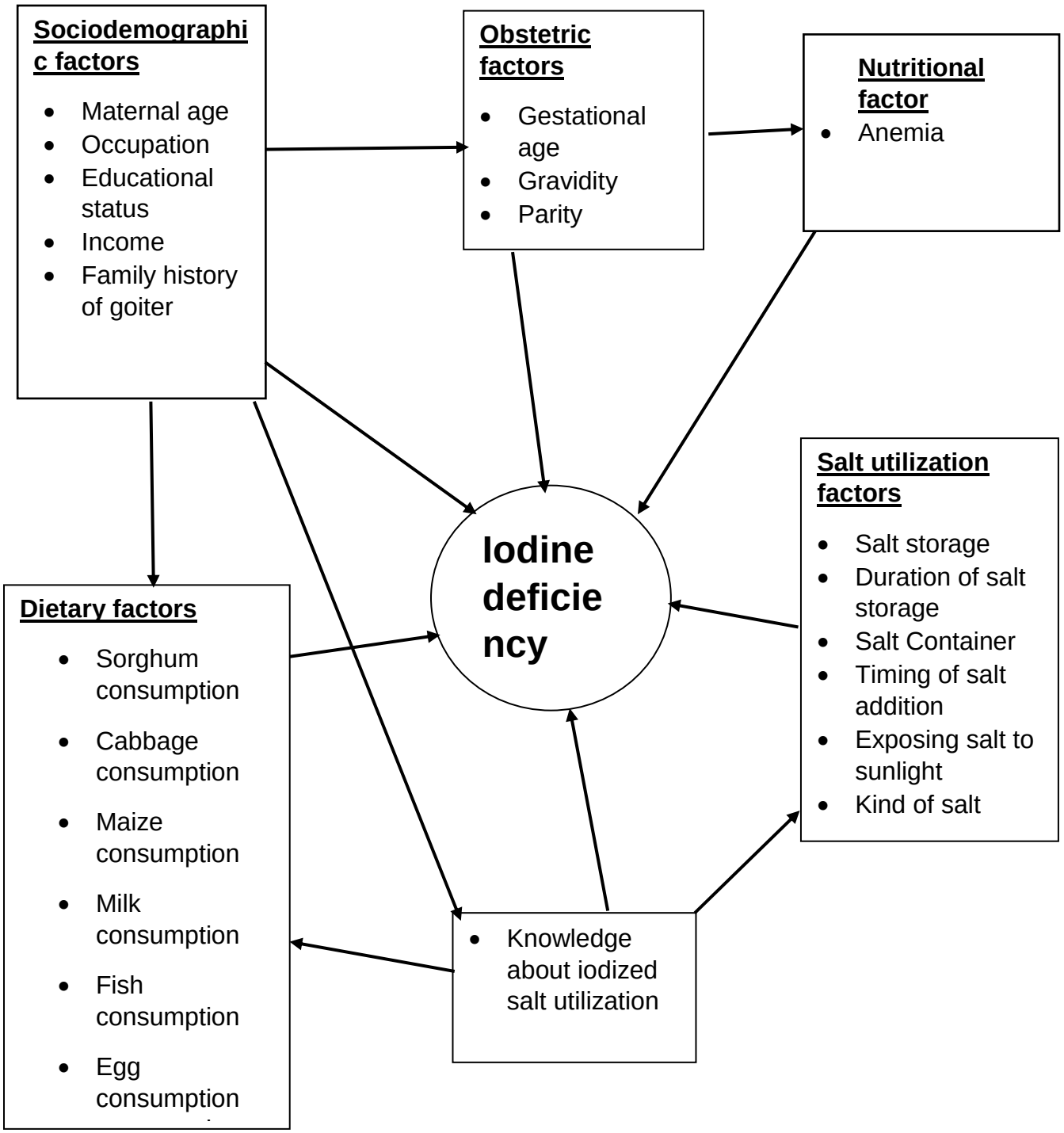

Figure 1. Conceptual framework on associated factors of iodine deficiency among pregnant women source: Adapted from different literature. *(26, 49, 52, 53, 58).*

1.2. Justification of the study

Ethiopia is working on 1000 days to improve the nutritional status of women and the newly born babies through essential nutrition action in which preventing iodine deficiency has been set as one strategy. Besides, to overcome all macro and micro nutrient crisis, identifying the potential risk factors is quite mandatory. This will be realized through conducting studies by the help of reliable and accurate assessment methods and tools.

The feasible and easiest strategies to create vibrant as well as productive generation is pointing out the problem and take corrective action earlier while in conception. Special emphasis should have been given for the pregnant women and children regarding iodine nutrition and supplementation; in that the burden of this micronutrient deficiency is not well addressed in the previous studies.

Therefore, investigating iodine deficiency through the gold standard diagnostic biochemical method (urinary iodine concentration), which believed to show the current iodine intake status for this segment of the population is paramount. Moreover, determining the prevalence of iodine deficiency and its associated factors among pregnant women will help designing nutrition projects and to strengthen the existing strategies for local decision makers. The findings of this study may be serving as baseline evidence for conducting further studies.

2. Objectives

2.1. General objective

To assess the prevalence of iodine deficiency and its associated factors among pregnant women attending antenatal care service at the University of Gondar Referral Hospital, Northwest Ethiopia, 2017

2.2. Specific objectives

- ✓ To determine the prevalence of iodine deficiency among pregnant women attending antenatal care service at University of Gondar Referral Hospital, Northwest Ethiopia, 2017
- ✓ To identify factors associated with iodine deficiency among pregnant women attending antenatal care at University of Gondar Referral Hospital, Northwest Ethiopia, 2017

3. Methods

3.1. Study design and period

An Institution based cross-sectional quantitative study was conducted from March 13 to April 25/2017.

3.2. Study area

The study was conducted at the University of Gondar Referral Hospital. Gondar city is found in the Northwest of Ethiopia which is far from 738 KM in Addis Ababa with an altitude of 2133 meter (6890 feet) above the sea level. In addition, the average rain fall is 116 mm per year and the weather condition is categorized in Woyna Dega. Regarding the dietary practice Cabbage, sorghum, maize and other cereals are the commonest food sources whereas, fish and other seaweeds are not ease to access. Concerning to the hospital; it is one of tertiary level hospitals in the country serving more than 5,000,000 people of the area and the neighboring region. The obstetric and gynecological care was started at the beginning of hospital establishment since, 63 years. Currently, the hospital is providing antenatal care for more than 1,030 pregnant women per month with 37 health care providers (15 midwives and 32 physicians).

3.3. Source of population and study population

3.3.1. Source of population

All pregnant women attending antenatal care clinic service at the University of Gondar Referral Hospital was considered as a source population

3.3.2. Study population

All pregnant women attending antenatal care clinic at the University of Gondar Referral Hospital during the data collection period.

3.4. Inclusion and exclusion criteria

Inclusion criteria

- ✓ All pregnant women who were attending antenatal care clinic at the University of Gondar Referral Hospital during the data collection period were included in the study.

Exclusion criteria

- ✓ Pregnant women who were unable to communicate because of seriously illness secondary to labor was excluded from the study.
- ✓ Known diagnosed hypertensive women with salt restriction were excluded.

3.5. Sample size and sampling procedure

3.5.1. Sample size determination

Sample size determination for proportion

To estimate the prevalence of iodine deficiency among pregnant women, the sample size was calculated using single population proportion formula by considering the following statistical assumptions; prevalence of iodine deficiency using urinary iodine concentration was (61.4 %) a study conducted in Lay Gayint District, Ethiopia(52). At 95% level of confidence and 5% margin of error.

Thus, n= $\frac{(\mathbf{1.96})\mathbf{2\ x\ 0.614(1-0.614)}}{(\mathbf{0.05})\mathbf{2}}$= 364

Considering 10% non-response rate the final sample size was

N=364*0.1=37 thus, 364+37=**401**

Sample size for factors

The sample size estimation for the second objective was calculated by reviewing different literature using Open Epi software and the two variables were selected after exhaustive calculation and comparison with other variables by considering the following statistical assumptions 95% Confidence Interval (CI), Crud odds ratio (COR), ratio of unexposed versus exposed(r), and proportions among exposed and non-exposed. The detail of sample size estimation was presented in the table below.

Table: A table showing sample size estimation

Ser. No.	Variables in previous studies	Assumptions	COR	Total sample size
1	Gestational age	95% CI, power =80%, r=1, **non-response rate 10%** proportions; P1=0.655 P2=0.5	0.5	301
2	**Cabbage consumption**	**95% CI, power =80%, r=1, non-response rate 10% proportions; P1=0.232 P2=0.767**	**2.2**	**403**

N.B.: The sample size for the second objective was found to be greater than the first thus, using the second objective's sample size was preferable.

Therefore, the final sample size for this study was **403.**

3.5.2. Sampling procedure

Systematic random sampling was employed to select study participants. Total pregnant women attending ANC per month were 1030 (report from University of Gondar Hospital ANC report sheet) so the study period was one and half month. Thus, total population of the study were (N) =1545

Final sample size (n) = 403

K=interval

Therefore, K=N/n=1,545/403

K=3.8≈4 Thus**,** Every K^{th} interval study participants were selected.

During data collection to get the initial study subject lottery method was used then after, every K^{th} (4) interval each study subjects were selected using systematic random sampling technique. Nevertheless, the selected study participants who did not fulfill the criteria or didn't want to participate after informed consent the next individual was included.

3.6. Variables of the study

Dependent variable

- Iodine deficiency

Independent variables

Sociodemographic variables: Age, religion, ethnicity, occupation, residency, income level, educational status, marital status, family history of goiter, and knowledge, attitude towards iodized salt and iodine deficiency disorder, husband employment, and husband educational status.

Obstetric and maternal factors: Gestational age, parity, gravidity, history abortion, and stillbirth.

Dietary factors: Sorghum, soya beans, cabbage, milk consumption, sweet potato consumption, maize consumption, fish consumption, and dietary diversity.

Salt utilization: place of salt storage, time of adding salt, salt container, kind of salt, duration of salt storage, and salt exposure to the sun/fire.

Maternal nutritional and health status: Mid Upper Arm Circumference (MUAC), anemia, and stool examination.

3.7. Operational definition

According to WHO Iodine deficiency is defined as women having urinary iodine concentration of <150µg/l (3).

Anemia

Pregnant women having hemoglobin level less than 11g/dl was considered as anemic (61).

Maternal nutritional status

Women having MUAC <23.3cm was considered as undernourished (62).

Women minimum Dietary diversity: Women consuming at least five and above food items was considered as adequate micronutrient intake(63).

Adequate Knowledge: The knowledge of study participants was determined after ranking the participants through factor analysis and categorized into two ranks

participants who were among rank number one was categorized as having adequate knowledge.

Favorable attitude: The attitude of study participants was determined after ranking the participants response among questions through factor analysis and categorized into two ranks participants who were among rank number one was categorized as having favorable attitude.

Wealth index: After analyzing through principal component analysis the wealth status of the participants was measured based on five quantiles according to EDHS 2016 report. Namely; richest, rich, middle, poor and poorer.

3.8. Data collection procedures and tools

The data was collected by using face to face interviewer-based validated tool which is developed from different literature and using EDHS. The tool contains sociodemographic characteristics, obstetric and maternal, dietary practice, dietary diversity, salt utilization attitude, knowledge, and wealth index questions. The data regarding anthropometric variables such as Mid Upper Arm Circumference (MUAC) was measured by tape on the left upper arm of women and interpretation was made based on the findings in centimeter (CM).

Urine and blood sample collection

Regarding the urine sample, five milliliter single spot urine sample was collected using clean plastic neck tube having tight screw-capped and labeled with study participant's identification number. Blood sample was collected using capillary tube. The collected urine sample was stored in the cold box for ease transportation and it was kept <-20 ºC in the refrigerator until analysis was done.

Laboratory Analysis

Urine Iodine level was measured by the Sandell-Kolthoff reaction method using (**Varian Cary, 50 UV-Vis spectrophotometer-Agilent, America**) at 420 nanometer wavelength, which is accredited by WHO/UNICEF/ICCDD(64). The blood sample was analyzed using hematological machines (Annex V).

3.9. Data management and quality control

The quality of the data was maintained by translating English version questionnaire to Amharic language then it was translated back to English to check its consistency. Pretest was conducted 5% of the calculated sample size (19 individuals) at Gondar poly health center and necessary amendment was made. Among the corrections spelling error, language ambiguity is described. Six health care professionals (four diploma holders and two BSC nurses were recruited for data collection and supervisor respectively. Prior to data collection data collectors and supervisors was trained by the nutritionist about over all purposes of the research, how to approach the study participants, and the way how to collect data. Furthermore, the principal investigator provided feedback on a daily basis to the data collectors. Completeness, accuracy, and clarity of the collected data was checked carefully on a regular basis.

To assure the quality of laboratory results, standard protocols were followed in pre-analytical, analytical and post-analytical phased of the laboratory testing process. ‘Low’, ‘normal’ and ‘high’ level controls were run daily in order to check the optimal reactivity of the reagent and functionality of the analyzer. All procedures were done strictly following the standard operating protocol prescribed by the manufacturer(s).

3.10. Data processing and analysis

The collected data was coded and entered into EP INFO version 7 then it was exported to SPSS version 20 for recoding and cleaning purposes again the data was exported to STATA version 13 for analysis of both descriptive and analytical statistical procedures. Descriptive statistics like frequency, percentage, cross-tabulation, and measure of central tendency with appropriate measure of dispersion was used for the presentation of demographic data and other necessary variables. Tables, graphs and other data summary mechanisms were also be used for data presentation. Binary logistic regression was fitted to identify factors associated with iodine deficiency. Bi-variable analysis was done and all variables which had P-value <0.2 were entered into multi-variable analysis model to control the possible effect of confounders. Model fitness was checked by Hosmer Lemishow assumption. Model selection was done by looking the likelihood result. Multicollinearity was checked by looking variance inflation factor (VIF).It has been verified that no multicollinearity problem. Finally the variables which had independent association with ID were identified on the basis of Adjusted Odds Ratio (AOR), with 95%CI and p-value less than 0.05. To measure the wealth index, knowledge and attitude questions Principal Component Analysis (PCA) was employed and all statistical assumptions was checked.

4. Ethical consideration

The ethical clearance was obtained from the IPH Institutional Review Board of the University of Gondar. Official letter was written to university of Gondar Referral Hospital. And permission letter was obtained from the University of Gondar Referral Hospital. Moreover, after a detailed discussion and explanations of the purpose, benefit and the possible risks of the study, written informed consent was obtained from each study participants. For those participants who were unable to read and write the information was read to them with their witnesses and they were convinced to put their finger prints in the informed consent format. The study participant's confidentiality was maintained by avoiding possible identifiers such as the name of the patient only numerical identification was used. The questionnaire was kept safe throughout the whole process of the research work. During data collection time any woman who with medical problem findings such as anemia, and malnourished individuals nutrition education was provided likewise, women with intestinal parasite infestation was treated by appropriate medications. Women who had grade two goiter they were linked to surgical side after providing nutrition education.

5. Result

Sociodemographic characteristics of pregnant women

A total of 378 study participants were included in the study making a response rate of 94%. The mean (±Standard deviation) age of the study participants was 26.3(±5.8) years. More than half of study participants 55% were in the age range 25-34 years. More than three fourth (82.5%) of study participants live in urban area. vast majority of the pregnant women were married (91.8%) and orthodox Christian in religion (89.9%).Besides, 60.1% and 26.2% of pregnant women had attended college and above educational status and governmental employed, respectively. Concerning on family members 86.2 % of households had less than four family size. Regarding, Hygiene and sanitation, almost all (96%) participants access water from tap and 33.3% study participants uses toilet flush to piped water type. (Table 1)

Table 1: Sociodemographic characteristics of pregnant women attending ANC service at the University of Gondar Referral Hospital, Northwest Ethiopia, 2017 (n=378).

Characteristics	Frequency	Percentage
Age		
15-24	126	33.3
25-34	208	55
35-49	44	11.6
Residence		
Rural	66	17.5
Urban	312	82.5
Religion		
Orthodox	340	89.9
Muslim	33	8.7
Others	5	1.4
Ethnicity		
Amhara	356	94.2
Tigre	22	5.8
Mother's Educational status		
Unable to read and write	22	5.8
Primary	129	34.1
College and above	227	60.1
Women's occupation		
Governmental worker	99	26.2
Merchant	54	14.3
House wife	200	52.9
Daily laborer	25	6.6
Marital status		
Single	28	7.4
Married	347	91.8
Divorced	3	0.8
Husband educational status		
Unable to read and write	85	25.1
Primary	74	22.3
College and above	188	52.6
Husband employment		
Governmental worker	144	38.1
Merchant	78	23.3
Unemployed	54	16.9
Farmer	30	10.8
Daily laborer	41	10.8

Wealth index		
Richest	75	19.8
Rich	76	20.1
Middle	76	20.1
Poorer	75	19.8
Poorest	76	20.1
Water source		
Tap water	359	96
Spring/river	19	4
Toilet		
Flush to piped sewer	126	33.3
Flush to septic tank	28	7.4
Ventilate improved Pit (VIP) latrine	86	22.7
VIP without slab	88	23.2
Open field	50	13.2

Obstetric and reproductive characteristics

Nearly 61% of study subjects were at third trimester by gestation while about 65% of participants were multigravida. Concerning in parity 176(46%) of subjects never gave birth before. Nearly 60% of participants were repeat ANC visitors. While 92% and greater than three fourth (88.1%) of study subjects did not have any history of still birth and abortion in their reproductive life respectively (Table 2).

Table 2: Obstetric and reproductive characteristics of pregnant women attending ANC service at university of Gondar Referral Hospital, Northwest Ethiopia, 2017 (n=378).

Characteristics	Frequency	Percentage
Gestational age		
First trimester	56	14.8
Second trimester	104	24.3
Third trimester	218	60.8
Gravidity		
Prim gravida	134	35.4
Multigravida	244	64.6
Parity		
Nulliparous	176	46.6
Para one	105	27.8
Multiparous	97	25.7
Number of ANC visit		
1st	152	40.2
2nd and above	226	59.8
History of still birth		
Yes	30	7.9
No	348	92.1
History of abortion		
Yes	45	11.9
No	333	88.1

Health, Dietary and nutritional status of pregnant women

Among the study participants majority 84% of them had no family history of goiter and 97.4% of individual have no any diarrheal disease in the past one week. The study pronounced that 19.6% of study participant were undernourished, while 18.5% of women were anemic. Regarding to intestinal parasite 23% were infested with different intestinal parasites like, ascariasis 9.8%, protozoal parasites 8.4%, and hookworm 5%. This finding revealed that 32% of study participants were took adequate micronutrient.

The study demonstrated that 61.4% participants consume cabbage twice and more than twice in a week besides, greater than half of study participants (54%) reported that they usually consume maize mixing with other foods. About 96%, 92.3% and 97.9% of individuals had never consume sweet potato, soya bean and fish in the previous one week respectively (Table 3).

Table 3: Dietary practice, and nutritional status of pregnant women attending ANC service at the university of Gondar referral hospital, Northwest Ethiopia, 2017 (n=378).

Characteristics	Frequency	Percentage
Cabbage consumption		
<=1/week	146	38.6
≥2/week	232	61.4
Sorghum consumption		
Yes	135	35.7
No	243	64.3
Maize consumption in the last one week		
Yes	174	46.0
No	204	54.0
Sweet potato in the last one week		
Yes	15	4.0
No	363	96.0
Soya bean in the last one week		
Yes	29	7.7
No	349	92.3
Fish in the last one week		
Yes	8	2.1
No	370	97.9
Milk in the last one week		
Yes	23	6.1
No	355	93.9
Meat in the last one week		
Yes	21	5.6
No	357	94.4
Egg consumption in the last one week		
Yes	358	94.7
No	20	5.3
Dietary diversity		
Adequate micronutrient	121	32
Inadequate micronutrient	257	68
Anemia		
Yes	70	18.52
No	308	81.48
Intestinal parasite		
Yes	87	23
No	290	77

Nutritional status		
Well nourished	304	80.4
Undernourished	74	19.6

Salt utilization characteristics

In the current finding, 88.1% of study subjects reported that they usually utilize packed salt. Most of participants 96%, and 98.4% reported that they never expose the salt to sunlight and wash salt to avoid impurities respectively. While 90.7% of participants store the salt in enclosed container. Majority of participants 94.4% were added salt at the end of cocking (Table 4).

Table 4: **Salt utilization characteristics of pregnant women attending ANC service at the university of Gondar referral hospital, Northwest Ethiopia, 2017 (n=378).**

Characteristics	Frequency	Percentage
Types of salt utilization		
Packed	333	88.1
Non packed	45	11.9
Exposure to sunlight/fire		
Never	363	96.0
Sometimes	15	4.0
Salt storage		
Dry	212	56.1
Moist	166	43.9
Do you wash salt		
Never	372	98.4
Sometimes	6	1.6
Salt containing container		
Open	35	9.3
Closed	343	90.7
Timing of salt addition to the food		
At the beginning	6	1.6
At the middle	15	4.0
At the end	357	94.4
Salt storage duration		
≤2 months	354	93.7
≥3 months	24	6.3

Pregnant women attitude and knowledge towards prevention of iodine deficiency characteristics

More than half 55.8% pregnant women had favorable attitude towards to iodized salt utilization and iodine deficiency. Whereas 50.1% study participants have adequate knowledge.

Prevalence of iodine deficiency

The overall prevalence of iodine deficiency was 60.5% (95% CI: 55.6, 65.5) with the median UIC of 137µg//L (IQR 80µg/L) which implies insufficient median urinary concentration (MUIC).The concentration was ranged from 27 µg/L, to 732 µg/L. none of them were sever iodine deficient (<20 µg/L) and single individual was in excessive iodine intake (Figure 2)

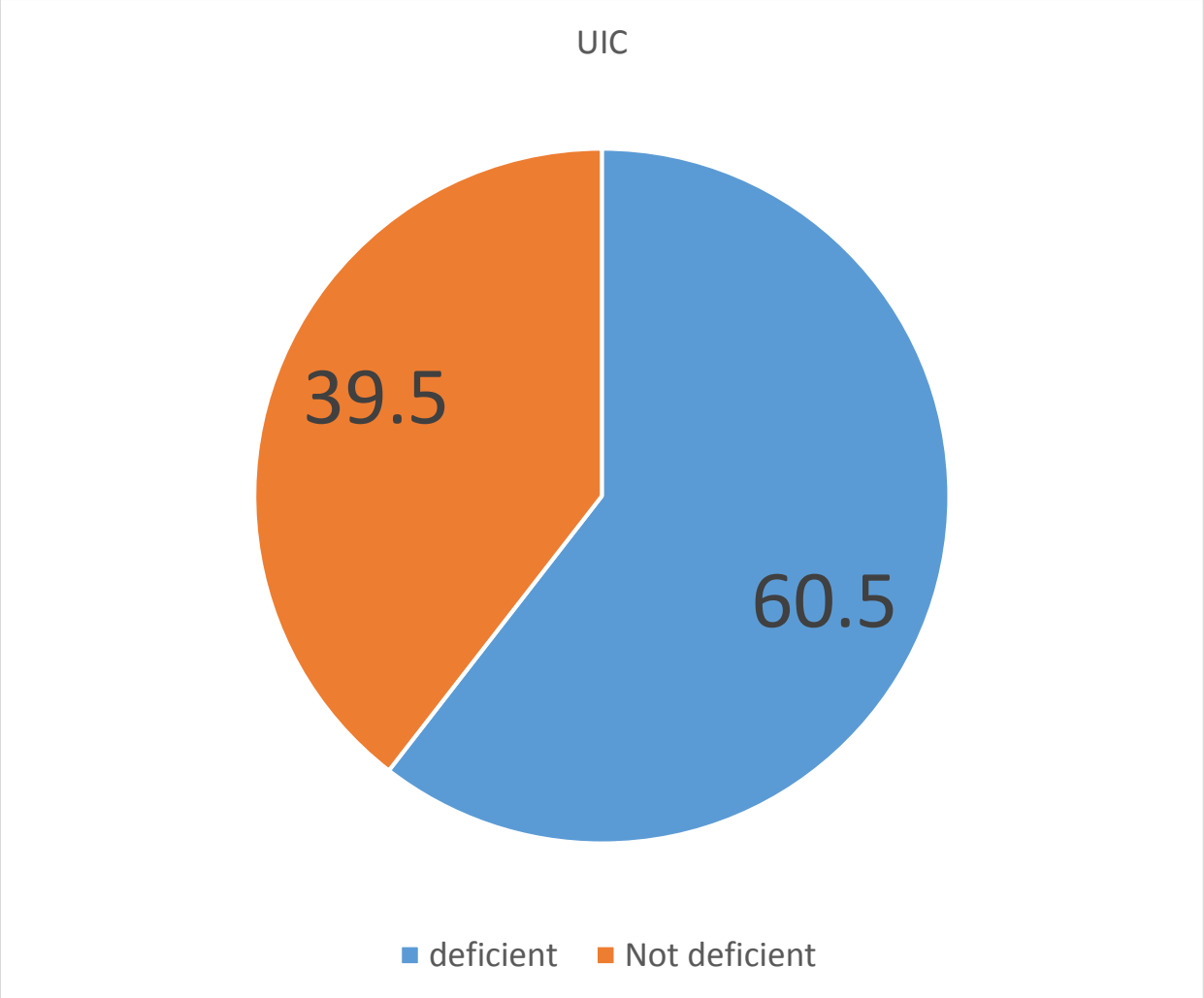

Figure 2. Urinary iodine concentration among pregnant women attending ANC service at university of Gondar referral hospital, 2017

Factors associated with iodine deficiency

In the bi-variable analysis, nine independent variables, namely, husband's employment, gestational age, gravidity, parity, cabbage consumption, types of toilet, maize consumption, sorghum consumption, and wealth status were found with a P- value of <0.2 and fitted to the multivariable logistic regression model.

However, in the adjusted analysis, husband employment, wealth status, gestational age, cabbage consumption and maize consumption were significantly and independently associated with ID.

The odds of iodine deficiency were decreased by 65% (AOR =0.42 (95%CI: (0.20, 0.87)) in pregnant women whose husbands were governmental employees as compared to whose husbands who were unemployed.

Concerning to the gestational age of the study participants being at second trimester was nearly three folds developing iodine deficiency during pregnancy than women who were at third trimester (AOR =2.43(95%CI:1.37, 4.32)).

Regarding to Cabbage consumption the odds of developing iodine deficiency among respondents who consume cabbage twice or more in a week was 2.3 times higher, as compared to participants who never consumes or consume once in a week (AOR= 2.35(95% CI: 1.44, 3.82)). Likewise, the odds of iodine deficiency was reduced by 71% (AOR= 0.29(95% CI: 0.18, 0.48)) among participants who never consume maize in the previous one week as compared to their counter parts.

The current study highly illustrated that the wealth status of pregnant women really matters the iodine nutrition status of the women. The odds of developing iodine deficiency among pregnant women who were poorer by economic status were 2.7 times higher as compared to women who were at highest(AOR= 2.7(95% CI: 1.24, 5.89)) (Table 5)

Table 5: Factors associated with iodine deficiency among pregnant women attending ANC service at university of Gondar referral hospital, Northwest Ethiopia, 2017 (n=378)

Variables	Urine iodine status		Crude odds ratio (COR)	Adjusted odds ratio (AOR)
	Deficient	**Not deficient**		
Husband employment				
Governmental	81	63	0.54(0.28,1.01)	**0.42(0.20,0.87)****
Merchant	54	34	0.67(0.33, 1.33)	0.57(0.26, 1.26)
Farmer	24	17	0.59(0.26, 1.35)	0.58(0.22, 1.56)
Daily laborer	25	16	0.65(0.28, 1.5)	0.72(0.28, 1.83)
unemployed	45	19	1.00	1.00
Gestational age				
First trimester	35	21	1.36(0.67, 2.62)	1.3(0.65, 2.72)
Second trimester	77	27	2.4(1.4, 4.11)	**2.43(1.37, 4.32)****
Third trimester	117	101	1.00	1.00
Gravidity				
Primi-gravida	158	29	1.54(0.77, 3.09)	
Multigravida	71	101	1.00	
Parity				
Nulliparous	97	79	1.00	
Para one	72	33	1.50(0.73, 3.09)	
Multiparous	60	37	1.05(0.48,2.30)	
Cabbage consumption				
≤1/week	73	73	1.00	1.00
≥2 times/ week	156	76	2.05(1.34,3.13)	**2.35(1.44, 3.82)*****
Sorghum consumption in the previous one week				
Yes	89	46	1.42(0.9, 2.2)	*
No	140	103	1.00	1.00
Maize consumption in the previous one week				
Yes	129	45	1.00	1.00
No	100	104	0.33(0.21, 0.51)	**0.29(0.18, 0.48)*****
Toilet				
Flush to piped sewer	72	54	1.00	
Flush to septic tank	20	8	1.8(0.76, 4.57)	*
Ventilate improved Pit (VIP) latrine	60	26	1.7(0.96, 3.09)	*
VIP without slab	45	43	0.7(0.45, 1.35)	*

Open field	32	18	1.3(0.67, 2.62)	*
Wealth index				
Richest	35	40	1.00	1.00
Rich	46	30	1.(0.91, 3.34)	1.56(0.76, 3.22)
Middle	47	26	2(1.06, 3.9)	1.88(0.88, 3.97)
Poorer	52	23	2.5(1.32, 5.04)	**2.7(1.24, 5.89)****
Poorest	49	30	1.8(0.98, 3.540	1.38(0.65, 2.91)

Note: 1.00 reference category

***=P-value<0.001

**=P-value<0.01

*=P-value<0.05

6. Discussion

Prenatal ID is the major, but preventable public health problem which is associated with unfavorable pregnancy outcome (abortion, stillbirth) and developmental failure following birth(22). Despite there is an improvement in the implementation of universal salt iodization since 2011 in Ethiopia, prenatal ID did not show significant reduction(6). The current prevalence of ID in this study was found to be 60.5% lied at the range (95% CI: 55.6, 65.5). In this study the median UIC was found to be 137µg//L (IQR 80µg/L) which depicts mild public health significance of ID in keeping with WHO/ICCID/UNICEF report(3).

The prevalence of ID in the present study is considerably higher than reports from developed countries, for instance in Canada (25.4%) (30) and Turkey 28.1% (34). The lower magnitude of ID in Canada could be attributed to the better socioeconomic of population. In addition, all study participants in Canada were well educated. So that this may help them to prevent ID. However, the discrepancy may not only limited by this socioeconomic variations, rather it extends to the provision of multivitamins containing iodine to the Canadian pregnant women which ultimately boosts their iodine status. Another possible explanation might be due to poor intake of iodine rich source foods as evidenced by in the current study among 355(93.9%) pregnant women who did not consume milk in the past one week 217(61.1%) were iodine deficient. Besides, this discrepancy could be explained by declaration of universal iodized salt utilization in developed countries has been long time. For instance in Turkey, universal iodized salt utilization was declared since 1998, Iodized salt consumers were 71.9%. Even though salt iodine status in the current study is not determined, the previous national studies reported that iodized salt coverage in Ethiopia was 23.3 % (65) which is far lower than recommended by WHO which is 90%. Besides, instead of deionized water the previous studies were done using distilled water which has direct effect on increment of iodine concentration and underestimate the problem. The above listed possible points could explain the discrepancy.

In the same way the current study is further up than studies conducted in Ghana (42.5%), Nepal (28.9%)(42) and Kolkata (37%)(47, 66). The possible justification for this variation

could be firstly, in this study among 370 participants who did not consume fish, which is a rich source of dietary iodine, 223 (60.3%) were iodine deficient. Secondly, this might be related with low iodized salt utilization in the area. For instance, iodized salt utilization in Nepal was (66.7%)(42) which is better than iodized salt coverage in Ethiopia 23.3(67) The previous studies in Gondar town (28.9)(68), and Dabat district (32.5%)(69). This figure is a shocking problem as compared to WHO expectation loss of iodine concentration from site of production to the consumers is 20%(70).

On the other hand, the current study is far lower than studies from European countries Czech Republic, (78.2%)(32), Ukraine (95.9%)(36), and France (77%)(37). The possible discrepancy for this study could be, participants who were enrolled to the study were small in number which results in difficulty of generalizability. Secondly, in Ukraine's study, all participants included in the study were below 16 weeks of gestation which ultimately increases demand of iodine. Lastly other dietary and ecological factors could explain the variation. Similarly, the study is surprisingly lower than studies where iodized salt utilization is adequate as in Bangladesh (80%) and Nigeria (100%) (45, 48). This discrepancy could be explained by the current study enrolled all pregnant women regardless of their gestational age. However, Studies in Bangladesh only women below 16 weeks of gestation were included. Another possible variation could be arise from geographical difference, methodological variation and etc.

Though the present study showed significantly lower prevalence of ID as compared to previous studies conducted in Ethiopia; Jima (88.9%), and Haramaya (82.8%)(50, 51) but, still the figure is unacceptably high. This could be low iodized salt utilization in these areas. It has been a witnessed that, study in Haramaya only 6.6% of household salt was iodized. However, study in Gondar showed that availability of iodized salt was 28.9%.. Another explanation could be increasing in public awareness towards iodized salt utilization from time to time, ecological difference between two study settings and other dietary practice could describe this discrepancy. Besides, Improvement of maternal health care utilization, other micronutrient supplementation like; iron folate, promotion of iodized salt utilization may explain the difference.

However, this study is in line with study conducted in Ethiopia, Gayint (61.4%), and Niger (61.6%) (49, 52).

The current study came up with the evidence that husband employment, gestational age, cabbage consumption, maize consumption, and wealth status were predictors for iodine deficiency during pregnancy.

In this study it was evident that husband employment status have contribution for the development of women's iodine deficiency during pregnancy. It has been observed that women whose husbands were governmental workers the odds of developing iodine deficiency was reduced by 60% than those women whose husbands were unemployed. This might be due to the cost of accessing better nutrition like; diary product and other diets which are enrich with micronutrients could be better. This is supported by a study from China in which lower income is responsible factor for the development of micronutrient deficiency (71). It could also explained by the different level of awareness among two groups of population. Likewise, the current study discovered that women who were in the lower class of wealth status were highly iodine deficient than women in the better position of income. This is consistent with study from Ethiopia; Jima (50). It is utterly known that for both micronutrient and macronutrient deficiency disorders income takes the lion share. This variation could be furtherly strengthened by a review from china showed that poor economic status was attributed to micronutrient deficiency (72).

Pursuant to this study, among the obstetric histories gestational age was statistically significant. The odds of developing ID among second trimester was higher as compared to third trimester. This finding is in agreement with study done in Ethiopia; Layi Gayint (52) being at third trimester by gestation was protective for the development of iodine deficiency. This result could be supported by a study from United kingdom (73) the concentration of urine iodine at third trimester was relatively much better than first and second trimester. It is because of requirements for thyroid gland formation for the growing fetus will not be a case after second trimester. This is because firstly, thyroid gland formation for the fetus begin at 12 week and ends at second trimester. Secondly, at 20th week of gestation the fetal thyroid gland starts to synthesize thyroid hormone with assistance of maternal thyroid hormone (74). In addition, the demand for Human Chorion

Gonadotropins (HCG) production at third trimester is not much required(75) because, this physiological process ends at the first and beginning of second trimesters. Due to the above listed facts, the severity of iodine deficiency in the latter pregnancy is relatively lower.

In spite of many health benefits of cabbage consumption it has also bad consequence following excessive consumption. The current study explored that cabbage consumption twice and more per week would result in iodine deficiency. This finding is similar with studies conducted in Jima, and Haramaya Ethiopia (50, 51). This is because of the substance thiocyanates is highly found in the cabbage and other cruciferous vegetables which is responsible for the reduction of thyroid peroxidase enzyme (TPO) enzyme and competing with iodine uptake by thyroidal cells(76). This explanation is furtherly complemented by other study done in south Bulgaria which showed that women who had lower urinary iodine were found to have high thiocyanates in their urine and TSH (77). Even though, literatures are not showing enough on the effect of maize in iodine deficiency among human species; this study revealed that maize consumption is positively associated with iodine deficiency. Randomized control trial study in animal model supports this finding. The study point out that a substance(thiocyanate) found in maize causes iodine deficiency by interfering the activity of TPO(78).

Unlike the current study the previous studies showed that consumption of milk, egg had a significant role in reduction of ID (51, 55) . This variation could be explained by sample size in the current study is smaller than the previous studies, and seasonal variation among two study settings.

The present study comes with high prevalence of iodine deficiency among pregnant women. Dietary, obstetric, and economical factors highly contribute to the increment of iodine deficiency. The finding suggested that iodine supplementation in this particular segment of population will be incomparable strategy to eliminate iodine deficiency because of its intergenerational problem. It is very valuable and informative which could give insights for health professionals and policy makers to reduce iodine deficiency.

This study might have had some strengths and limitations. Among the strengths; outcome variable was ascertained by laboratory experiment and the study was supported with

other additional laboratory based diagnosis such as, hemoglobin and stool examination. Nevertheless, this study had some limitations for instance, it would have been better if the study determined household iodized salt utilization status of pregnant women. Data collection season may affect the result, it was hot season which believed to be increased urine iodine concentration artefactual(79). Furthermore, recall and social desirability bias in regard to dietary practice may be considered as some of the shortcoming of this study.

7. Conclusion

The prevalence of Iodine deficiency among pregnant women was found to be high. Husband employment, wealth status, cabbage consumption, maize consumption, and gestational age was found to be statistically significant correlation with iodine deficiency during pregnancy.

8. Recommendation

Local decision makers

- ✓ Nutrition education regarding iodine rich and poor source of food items should be given for the community
- ✓ It would be better if economic enhancement is done for pregnant women
- ✓ It would be better if special attention is given for pregnant women special women with second trimester of pregnancy
- ✓ It would be better if special attention is given for unemployed to have job
- ✓ It would be good if other nutritional strategy is done to reduce the burden of ID

For researchers

- It will be better if salt iodine test will be done along with urinary iodine determination
- Follow up study should be conducted to see the pregnancy outcomes

For pregnant women

- Minimize frequent of intake concerning Goitrogenic foods like; cabbage, maize
- Special attention would be given at second trimester of pregnancy
- Encourage husbands to create jobs and make money

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10. Annexes

Annex I: Information sheet

My name is _____ I am a student at the University of Gondar College of medicine and health Sciences.

I am currently conducting a research as partial fulfillment for the requirement of Master in public Health nutrition at the University of Gondar entitled prevalence and associated factors of iodine deficiency among pregnant women attending antenatal care clinic at university of Gondar hospital. You are selected to be one of the participants in the study and you are kindly requested to give small amount of blood and urine. There will be some pain during pricking of your finger but not harmful to your health. You will not have any incentives from the project. Nevertheless, the result of the study after identifying the burden and the possible factors that leads to iodine deficiency will be important to prevent the occurrence of iodine deficiency during pregnancy. If you do not want to answer all or some of the questions, you do have the right to do so. And even you have the right to withdraw in between the study. Your refusal will not affect you from getting any kind of health-related services. However, your willingness to answer all of the questions is very important to know the prevalence of iodine deficiency and its associated factors among pregnant women to take action accordingly. In this form your name will not be described and the information you give will be kept confidential. If you agree to give samples you are requested to answer questions including socio-demography, past and present history of pregnancy.

Annex II: Consent form

If you have any questions you may ask me now or later, even after the study has started. If you wish to ask questions later, you may contact any of the following individuals:

1. Wubet worku

Cell phone: 0915 861683

Mail: wubetworku09@gmail.com

2. Mekuriaw Alemayehu

Cell phone: 0920510050

Mail: mekuriaw04@gmail.com

3. Terefe Derso
   Mail: dersotere@gmail.com

Cell phone: 0923421096

You can ask me any more questions about any part of the research study, if you wish to. Do you have any questions?
The information has been read to me. I have had the opportunity to ask questions about it and any questions that I have asked have been answered to my satisfaction. I consent voluntarily to participate as a participant in this research.

Name of Participant_____

Signature of Participant _____

Date _____ Day/month/year

For those who are unable to read and write

I have witnessed the accurate reading of the consent form to the potential participant, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

Name of witness_____ AND Thumb print of participant

Signature of witness _____

Date _____ Day/month/year

Statement by the investigator

I have accurately readout the information sheet to the potential participant, and to the best of my ability made sure that the participant understands that the following will be done:

1. Urine sample will be taken

2. Blood sample

3. MUAC measurement will be done

4. Interviewing questionnaires

I confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

Name of Researcher/person taking the consent_____

Signature of Researcher /person taking the consent_____

Date _____ Day/month/year

To be filled by data collectors and supervisors

Name of Data collectors& supervisors		Signature
Data collector name	_____	_____
Supervisor name	_____	_____
Data collection date	_____	

Annex III: English version questionnaire

Part I: Sociodemographic characteristics of the respondents

Code No._____

No	Questions	Alternatives	Skip
SD101.	Age	---------- years	
SD102	Place of Residence	1. urban 2. rural	
SD103.	Religion	1. Orthodox 2. Muslim 3. Protestant 4. Catholic 5. Others specify_____	
SD104.	Ethnicity	1. Amhara 2. Tigre 3. Oromo 4. Others	
SD105.	Educational status	1. Cannot read and write 2. Read and write 3. Grade1-8 4. Grade 9-12 5. College/ university degree	
SD106.	Occupation	1. Merchant 2. Daily laborer 3. Government employee 4. House wife	

		5. Farmer 6. Student	
SD107.	Marital status	1. Married 2. Single 3. Divorced 4. Separated 5. Widowed	
SD108.	If married what is your husband educational status?	1. Cannot read and write 2. Read and write 3. Grade1-8 4. Grade 9-12 5. College and above	
SD109.	Husband employment	1. Merchant 2. Daily laborer 3. Government employee 4. Farmer 5. Student Others (specify)____	
Part II: Hygiene and sanitation			
HS201.	Where do you access drinking water	1. Tape water 2. Protected spring 3. Unprotected spring/river	
HS202.	What type of latrine facility do you have?	1. Flush to piped sewer system 2. Flush to septic tank 3. Ventilated improved pit (VIP) latrine 4. Pit latrine without VIP a slab 5. Open field	
Part III: Obstetric and health history			
OH301.	Gestational age	_____weeks	
OH302.	Number of ANC visit including the current one	_____in number	
OH303.	Gravidity (how many times that you have been pregnant?)	_____in number	
OH304.	Parity (how many times that you give birth?)	_____in number	
OH305.	Did you experienced any diarrheal past one month?	1. Yes 2. No	

OH306.	Is there any history of still birth?	1. Yes 2. No	
OH307.	If yes for Q No.206 how many times?	_____ in number	
OH308.	Is there any history of abortion	1. Yes 2. No	
OH309.	If yes for Q No.208 how many times?	_____ in number	
OH310.	Is there any family history of goiter?	1. Yes 2. No	
Part IV: Dietary practice of the respondent			
DP401.	How often do you consume the following foods in a week?	1. Cabbage_____times 2. Fish_____ 3. Meat_____ 4. Milk_____ 5. Egg_____	
DP402.	Among the following list of foods which one is you consume frequently in your home in the last one weeks **?(more than one answer is possible)**	1. Sorghum 2. Maize 3. Soya bean 4. Sweet potato	
Part V:Salt utilization characteristics			
SU501.	What type of salt you usually utilize?	1. Packed 2. Not packed	
SU502.	Where do you store salt?	1. Dry area 2. Moist area	
SU503.	Did you expose the salt to sunlight/fire	1. Never 2. Sometimes 3. Always	
SU504.	Did you wash the salt to remove impurities?	1. Never 2. Rarely 3. Usually 4. Always	
SU505.	When do you add the salt while you cock food?	1. At the beginning 2. At the middle 3. At the end	
SU506.	In what kind of container you store the salt?	1. Closed 2. Open	
SU507.	For how long did you store the salt once you bought?	_____in months	
Part VII: Maternal Attitude towards iodized salt utilization			

Code	Questions	Response	Skip
Att701.	Do you think that the test of iodized salt is different from un iodized one?	1. Yes 2. No 3. I don't think	
Att702.	Do you agree iodized salt has a harmful effect on health?	1. Yes 2. No 3. I don't think	
Att703.	Do you think that salt obtained from the sea already contains iodine in the right quantities to support human growth and ensure optimal health?	1. Yes 2. No 3. I don't think	
Att704.	Have you ever seen people with swelling in the neck in your community?	1. Yes 2. No	
Att705.	If yes for Q 704 what do you call it the swelling?	_____	
Att706.	What are the causes of this swelling?	_____	
Att707.	What do you think the treat of swelling?	1. Health Center 2. Hospital 3. Traditional Medicine 4. I don't know 5. Others specify_____	
Att708.	Do you think that regular consumption of iodized salt can prevent this swelling?	1. Yes 2. No 3. I don't think	
Part VIII: Maternal knowledge about use of iodized salt related characteristics			
MK801.	Have you heard about iodized salt?	1. Yes 2. No	
MK802.	If your answer is yes for MK802, what is the source of information?	1. Radio 2. TV 3. Printed materials 4. Relatives/friends 5. Health workers 6. Others(specify) _____	
MK803	What are the importance of using iodized salt? (**Multiple responses are possible)**	1. Prevents of goiter 2. Growth and development 3. I don't know 4. Others(specify) _____	

MK804	What are the richest source of iodine? (**Multiple responses are possible)**	1. Egg 2. Meat 3. Milk and milk product 4. Iodized salt 5. Fish 6. Others(specify) _____ 7. I don't know	
MK805	Do you know that all salts contain iodine?	1. Yes 2. No 3. I don't know	
MK806	Can you list any problems/disorders resulting from lack of iodine in the diet? (**Multiple responses are possible)**	1. Mental retardation 2. Goiter 3. Cretinism 4. Retarded growth 5. Abortion 6. Child mortality 7. I don't know 8. Others (specify)_____	
MK807.	What type of salt household should use for food preparation?	1. Iodized 2. None iodized 3. I don't know	
MK808.	When the household should add the salt while they are preparing food?	1. At the beginning of cooking 2. At the middle of cooking 3. At the end of cooking 4. I don't know	
MK809.	Where the household should store the salt?	1. Near to fire 2. Away from fire 3. I don't know	
MK810	How the household should store the salt?	1. With closed container 2. With open container 3. I don't know	
MK811.	Is there any law in Ethiopia that prevents selling none iodized salt for human consumption?	1. Yes 2. No	
Part VIII: Wealth index related characteristics			
WI901	Ownership of the house	1. Private 2. Rented from individual 3. Others (specify)_____	

WI902	How many rooms is there in your home?	_____in number	
WI903	What is the main material of the dwelling floor?	1. Earth / Sand 2. Cement 3. Bamboo 4. Carpet 5. Others (specify)_____	
WI904	What is the main material of the roof?	1. Iron corrugated sheet 2. Wood 3. Thatch 4. Bamboo 5. Others (specify)_____	
WI905	What is the main material of the exterior walls?	1. Stone with mud 2. Wood with mud 3. Stone with cement 4. Others (specify)_____	
WI906	What type of fuel mainly used for household cooking?	1. Electricity 2. Charcoal 3. Wood 4. Animal dung 5. Others(specify)___	
WI907	Is the cooking usually done in the house, in a separate building, or outdoors?	1. In a separate room used as kitchen 2. Elsewhere in the house 3. In a separate building 4. Outdoors 5. Other (specify)_____	
WI908	How many hector of agricultural land do you have?	_____	WI909
WI909	Annual total agricultural products(includes all items)	_____kuintal	
WI910	Does your household have A. Electricity? B. A Radio? C. A Television? D. A Non-mobile telephone?	Yes / No 1 / 2 1 / 2 1 / 2 1 / 2	

	E. A Refrigerator? F. Table? G. Chair? H. A bed with cotton/spring mattress	1 2 1 2 1 2 1 2	
WI911	Does any member of your household own A. A watch? B. A mobile phone? C. A bicycle? D. A Bajaj? E. Animal drawn cart? F. Car?	Yes No 1 2 1 2 1 2 1 2 1 2 1 2	
WI912	Does this household own any livestock, herds, other farm animals, or poultry?	1. Yes 2. No →	WI914
WI913	How many of the following animals do the household have? (if the household does not have the listed animal use **999**)		
1.	A. Cattle, milk cows, bulls?	_____in number	
2.	B. Horses, Donkeys, or mules?	_____in number	
3.	C. Goats?	_____in number	
4.	D. Sheep?	_____in number	
5.	E. Chickens?	_____in number	
6.	F. Beehives?	_____in number	
WI914	How much money do you have in the bank?	_____birr	
Part X: Physical examination and lab results			
Lab1001	Concentration of iodine in the urine	_____(µg/L)	
Lab1002.	Mid Upper Arm Circumference (MUAC)	_____cm	
Lab1003.	Hemoglobin	_____mg/dl	
Lab1004.	Stool	1. No ova parasite 2. Hook worm 3. A. Lumbricoid 4. T. Tricuria	

		5. Giardia 6. Others(specify)___	

Part VI: Women dietary diversity Questionnaire

Dietary diversity for 15-49 years old women in the past 24 hour dietary practice

	Food category		**Consumed Yes=1 No=0**
DD1001.	Any food which is made from Grains, white roots and tubers, and plantains	Breads, rice, stiff porridges of maize, sorghum/millet,pasta, potatoes,teff,wheat,rice,barley,maize,and oats.	
DD1002.	Any food which is made from Pulses (beans, peas and lentils)	bean, pea, lentil	
DD1003.	Any food which is made from Nuts and seeds	sesame, flax, sunflower, and nuts	
DD1004.	Any food which is made from Dairy and dairy products	Milk, soft and hard cheeses and yoghurt	
DD1005.	Any food which is made from Meat, poultry and fish	Meats, organ meats, poultry ,fish beef	
DD1006.	Any food which is made from Eggs	Eggs from any type of bird	
DD1007.	Any food which is made from Dark green leafy vegetables	Chili, Swiss chard,mustard	
DD1008.	Any food which is made from Other vitamin A-rich fruits and vegetables	Potato,carrot, pumpkin ,pepper, and deep yellow- or orange	
DD1009.	Any food which is made from Other vegetables	Onion, Tomato,and cabbage, and mushroom	
DD1010.	Any food which is made from Other fruits	Orange, Banana, Avocado, watermelon, Appel,and Lemon	

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Annex IV: Amharic version questionnaire

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Annex V: Laboratory procedure

Materials

1.0 M Ammonium persulfate,

Arsenious acid solution

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$Ce(NH4)_4 (SO4)_4$

Deionized H2 O

KIO3

1.0 M Ammonium persulfate: Dissolve 114.1 g H2 N2 O8 S2 in H2 O; make up to 500 ml

Arsenious acid solution: In a 2000 ml Erlenmeyer flask, place 20 g $As_2 O_3$ and 50 g NaCl, then slowly add 400 ml 5 N $H_2 SO_4$. Add deionized water to about 1 litre, heat gently to dissolve, cool to room temperature, dilute with water to 2 litres, filter, store in a dark bottle away from light at room temperature. The solution is stable for months.

Ceric ammonium sulfate solution: Dissolve 48 g ceric ammonium sulfate in 1 litre 3.5 N H2 SO4. (The 3.5 N H2 SO4 is made by slowly adding 97 ml concentrated (36 N) H2 SO4 to about 800 ml deionized water (careful - this generates heat!), and when cool, adjusting with deionized water to a final volume of 1 litre). Store in a dark bottle away from light at room temperature. The solution is stable for months.

Standard iodine solution, 1 µg iodine/ml (7.9 µmol/l): Dissolve 0.168 mg KIO3 in deionized water to a final volume of 100 ml (1.68 mg KIO3 contains 1.0 mg iodine; KIO3 is preferred over KI because it is more stable. It may be more convenient to make a more concentrated solution, e.g., 10 or 100 mg iodine/ml, then dilute to 1 µg/ml. Store in a dark bottle. The solution is stable for months. Useful standards are 20, 50, 100, 150, 200, and 300 µg/l.

Procedure

Step	Action
1.	Mix urine to suspend sediment
2.	Pipette 250 µl of each urine sample into a 13 x 100 mm test tube. Pipette each iodine standard into a test tube, and then add H_2 O as needed to make a final volume of 250 µl. Duplicate iodine standards and a set of internal urine standards should be included in each assay.
3.	Add 1 ml 1.0 M ammonium persulfate to each tube.
4.	Heat all tubes for 60 minutes at 100^o C in the oven.
5.	Cool tubes to room temperature.
6.	Add 2.5 ml arsenious acid solution. Mix by vortex. Let stand for 15 minutes.
7.	Add 300 µl of ceric ammonium sulfate solution to each tube (quickly mixing) at 15-30 second intervals between successive tubes. A stopwatch should be used for this. With practice, a 15 second interval is convenient.
8.	Allow to sit at room temperature. Exactly 30 minutes after addition of ceric ammonium sulfate to the first tube, read its absorbance by using UV-Vis spectrophotometer at 420 nm. Read successive tubes at the same interval as when adding the ceric ammonium sulfate.

Calculation

Construct a standard curve on graph paper by plotting log absorbance of each concentration versus iodine concentration of each standard.

Iodine in µg/l=((log A-b)/(m))*10

Where log A is Absorbance of sample

b is intercept of the graph

m is slope of the graph

Annex VI: Declaration

I, the undersigned, senior MPH student declare that this thesis is my original work in partial fulfilment of the requirement for the degree of Master of human nutrition
Name: Wubet Worku
Signature: _____

Place of submission: Institute of public health, College of Medicine and Health Sciences, University of Gondar.

Date of Submission: _____

This thesis has been submitted for evaluation with our approval as university advisor(s).

Advisors

	Name	Signature
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